SILVICULTURE OF VARIETAL LOBLOLLY PINE PLANTATIONS: EVALUATION OF SPACING AND SILVICULTURAL TREATMENTS ON GROWTH AND INTRACLONAL UNIFORMITY

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During the last decades, the efforts in genetic improvement have contributed to increase productivity of loblolly pine in the South (McKeand et al. 2003). Recently, there has been increased interest in developing varietal forestry. It has been reported that higher genetic gains can be achieved by using varieties, resulting in higher yield and phenotypically more uniform stands (Zobel and Talbert 1984). Also, it has been argued that the potential deployment of elite genotypes will require intensive levels of silviculture including site preparation, weed control, fertilization, and spacing.

Working at a variety level, the expected responses in growth may vary considerably due to site or silvicultural treatment differences. Stoval et al. (2010) found contrasting results for different loblolly pine varieties in response to fertilization, which were tested in the same site conditions. Some varieties showed positive response to fertilization, others did not response, and a few of them exhibited a negative response. On the other hand, increasing the genetic uniformity is not necessarily associated with an increase in the uniformity of growth or physiological traits (Aspinwall et al. 2011). In this report, we present some preliminary results of two-years trials located in two contrasted sites in the southern United States (Virginia Piedmont and North Carolina Coastal Plain), where the same genotypes were planted and managed using intensities of silviculture.

Materials and Methods

A study of varietal silviculture of loblolly pine was established in 2009 at two sites in the southern U.S. One site was located in the Virginia Piedmont at the Virginia Tech Reynolds Homestead Research Center. Soils at this site were well-drained Fairview series. This site previously supported a mixture of loblolly, Virginia and white pine stands that were harvested in 2007 and 2008. The second site was located in the North Carolina Coastal Plain at Bladen Lakes State Forest. Soils at this site were poorly drained Rains series. This site previously supported a loblolly pine stand. The study was a split-split plot design with two levels of silviculture (operational and intensive) as the main plots, six genotypes entries (1OP, 1CMP, 4 clones) as sub-plots, and three different planting densities (250, 500, and 750 trees per acre) as sub-sub-plot. At the Reynolds site, the experimental unit consisted of block-plots of 81 trees (in an arrangement of 9 by 9 trees) with 4 replicates. At the Bladen site the experimental unit was a block-plot of 63 trees (in an arrangement of 9 by 7 trees) with 3 replicates.

The site preparation at both sites was a chemical application, followed by a broadcast burning at Reynolds, and a V-blade bedded using a Savannah bedder at Bladen. The operational silviculture consisted of a banded weed control during the first growing season, whereas the intensive silviculture included broadcast herbaceous weed control during year 1 and 2 and an application of fertilizer (150 lbs/acre N + 25 lbs/acre P) during the winter prior to the start of the second growing season. The genetic entries consisted of 1 open pollinated family (OP), 1 mass control pollinated family (CMP), and four varieties designated C1, C2, C3 and C4. The varieties C3 and C4 were selected as having a wide crown ideotype, whereas C1 and C2 were selected having a moderately broad crown.

Total height and crown width were measured during winter (January 2010 and January 2011). Crown width was measures twice, parallel and perpendicular to the planting row, and the average per tree was used for used in the analysis. The means and coefficient of variation was calculated at each experimental unit, which were subjected to analysis of variance to determine the sources of variability in growth and uniformity. The analyses of variance were done with the MIXED procedure of the Statistical Analysis System (SAS), version 9.2 (SAS Institute, Cary, NC, USA).

Results and Discussion

At the end of the second growing season, tree height was a 39% higher at Reynolds (Virginia Piedmont) than in Bladen (North Carolina coastal plain, Figure 1). The levels of the water table in the poorly drained soils at the Bladen site, which probably affected tree development at this stage. However, we anticipate that the growth will be greater at Bladen in the future when tree development increases and higher evapotranspiration rates decrease water table level. Moreover, a higher variability of growth was present in the plots at Bladen than Reynolds, with within-plot coefficient of variation of 41% and 26% in the second year, respectively. Microtopographic differences in soil drainage likely affect root growth and increase heterogeneity in growth across the landscape in the second year. At the Reynolds site, where the soils are well drained, there was not an increase in the plots variability across the years (Figure 1).

There was no significant effect of planting spacing and silvicultural treatments after 2 years. However, plots having intensive silviculture performed better in growth at the two sites. The averages for tree height at the second year were 23% and 7% higher with intensive silviculture than operational at the Bladen and Reynolds sites, respectively. The high variability in growth within the plots probably masked the differences in the silvicultural treatments at this age.

At the two sites, there were significant differences among genetic entries for all the variables. Means tree height for the varieties were significantly different from the OP and CMP families at both sites and years (Figure 1). Moreover, higher within-plot uniformity was found using varieties, supporting the hypothesis of varietal forestry in which increasing the genetic uniformity should increase the stand yield and uniformity. These results must be carefully interpreted because of the narrow genetic diversity tested. Increasing the genetic uniformity is expected a major genetic control of quantitative traits of interest such growth, and uniformity; however, there is some evidence contradicting this fact (Aspinwall et al. 2011). Although varieties had similar growth rates each site, variety 4 was more uniform (lower CV) at both sites, which highlights the importance of selection from this point of view.

There was a positive correlation between crown width and tree height, with values of 0.82 and 0.7 for Bladen and Reynolds site, respectively. Varieties had greater crown width values than families, but there were not differences between the varieties with different crown ideotype at this stage. Despite of the young age of the trees, our preliminary results showed that growth and uniformity was higher in plots containing varieties than families, and that differences are accentuated with intensive silviculture.

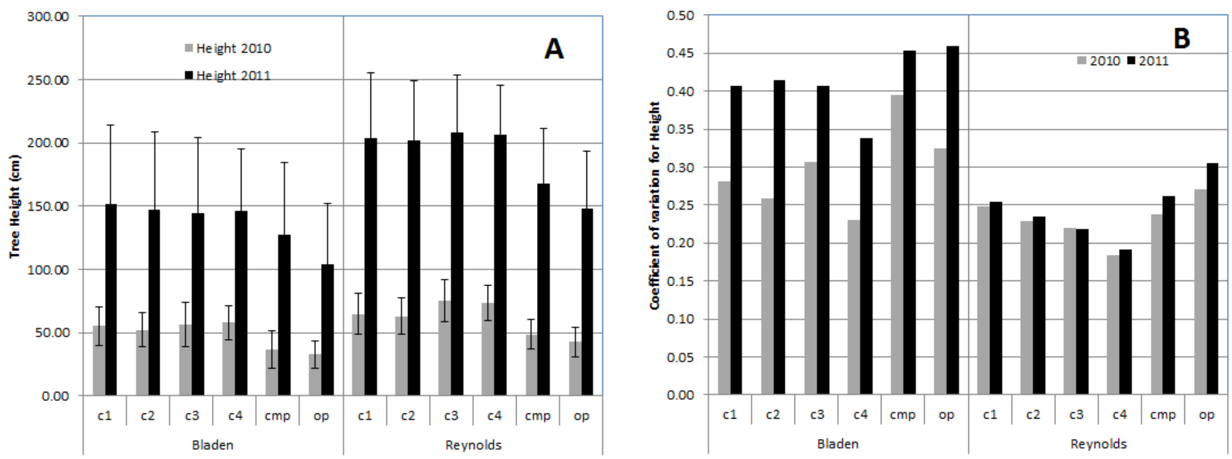

Figure 1. (A) Means tree height obtained per site and genetic entries during the first two years. Bars designate one standard deviation. (B) Coefficient of variation of each site and genetic entries during the first two years.

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